digital connection

BY DON ROTOLO,* N2IRZ

NW Digital UDRX-440 Data Radio

This time I want to introduce you to a new, high-speed data radio, but before I get started, the delivery kerfuffle from February and the combined March/April issue conspired to throw off the schedule, with April appearing in May and my skipping June entirely to land us right here in August. This should bring us back on frequency to stay, so my personal thanks for your patience during the interim.

When I first got my license back in the early 1980s, packet radio was just gaining momentum in the amateur community due to the release of the TAPR TNC-2. It operated at 1200 Baud, which was a good speed at the time (considering that most telephone modems also ran at that speed), and some were experimenting with the blazing-fast speed of 9600 (9k6) Baud. Just a few years later, you could buy a TEKK KS-900 data radio (fig. 1) for a few hundred dollars, including crystals, and run 2 watts on 70 centimeters at 9k6 out of the box. For somewhat more cash one could get a WA4DSY RF modem that would run at 56k, but since you had to use a transverter (its output was at 28–30 MHz at 1 mW) to get up to a usable frequency, it wasn't wildly popular despite the amazing data rate it supported.

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Fig. 1. A TEKK KS-900 (T-Net Micro) data radio. This is a 2-watt crystal-controlled data radio that runs 9600 Baud out of the box, and can be tweaked to push 19,200 Baud. For several years, this was the best one could hope for when running packet backbone links on 70 centimeters. The DE-9F connector is for power and data.

In the intervening years, most FM voice radios have gained the capability of running mid-speed (9k6) data without modification, but owing to the general decline in packet radio networks and perhaps the awful specs of some of these radios (such as TXDelay), these capabilities were only lightly used if at all.

Then came D-STAR, which for pure data offers a 128k data channel and an Ethernet port, albeit on 1.2 GHz and at 10 watts. Even with Icom being the only manufacturer offering compatible equipment, the benefits of D-STAR Digital Voice (DV) and high-speed Digital Data (DD) outweighed the costs, making D-STAR the de-facto DV solution for many. Still, most stayed with their comfortable and familiar analog FM radios since the cost of a new radio and perhaps the even higher cost for a DV repeater just wasn't in the budget.

More recently, a bunch of D-STAR compatible systems have reached the market. For example, in the May issue of *CQ*, I introduced the DVRPTR v1 board offered for sale in North America from dvrptr.net <http://www.dvrptr.net>. It isn't a radio, but it makes good use of your modern rig's data capabilities. Google "D-STAR compatible" to get an idea of what else is out there.

In researching an idea for an article on data compression, I was pointed to John Hays, K7VE, and NW Digital Radio, but when I saw their website <http://nwdigitalradio.com/> and found their UDRX-440 (fig. 2), I got really excited: A high-speed (~100 kb/s), high-power (25 W) data radio built for the 430–450 MHz (70 cm) band.

OK, fair disclaimer: It *should* be able to run 100 kilobits per second. Nobody's done it yet (as far as I know), but 56 kb/s is within easy reach (and has been done on a test basis while staying within the bandwidth limits of FCC Part 97.306(f)(6) by encoding more than one bit per symbol). There doesn't appear to be any technical reason why it couldn't be pushed somewhat faster. Someone just has to write the software to do it.

Ah, yes: Software. This is no ordinary radio, no: It is a *Band-Limited Software-Defined Radio* (SDR). Limited to the 70-cm band, it's an SDR in the sense that modulation (and demodulation) of signals are all done in software, but limiting the RF deck to a single band allows for high power, along with great receiver performance, at a low cost. Plus, it has this great little computer inside (running Debian Linux) so it can do all sorts of tricks. More on the radio specs and what you can do with it in a moment.

Quoting from a message I received:

> In 2010, Bryan [Hoyer K2UDR] and Basil [Gunn N7NIX] traveled to the TAPR/DCC conference in Vancouver, WA where they attended a presentation by John Hays [K7VE] on D-STAR. At the end of John's talk he presented a list of things he would like to see created for D-STAR. One item stood out for Bryan and Basil:

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it was a radio that had an antenna connection on one end and an Ethernet port and power on the other, that could be used provide higher speed data communications using D-STAR's Digital Data (DD) protocol on the 70cm band in 100 kHz of bandwidth. The radio would be completely controlled by a network interface and would transport packets from Ethernet to ether (RF) and back. Bryan approached John and said, "I want to build that radio!" That's how NW Digital Radio came to be.

One-and-a-half years later, having been joined in their endeavor by Dennis Rosenauer, AC7FT, the first low-power prototype was ready, but performance wasn't up to expectations. By the fall of 2012, they decided to redesign the radio, and to make a long story shorter, you will be able to buy one just a few weeks after you read this for under $400.

Even before the radio was ready, they identified a need for an AMBE™ Vocoder (remember their focus was on D-STAR), so they built a card which (like the DVRPTR) is compatible not only with the computer inside the UDRX-440 but also with the common Raspberry Pi microcomputer. Their DV3000 card converts audio to AMBE and back, supporting not only the D-STAR AMBE Vocoder "but also all major AMBE formats used in Digital Voice radio." Also like the DVRPTR, you can buy one now for under $100.

OK, so back to the radio. What we have is a computer running Linux, four USB ports and a 10/100 Ethernet port. There's a web browser interface on the Ethernet port, meaning most any device capable of browsing the web will let you control it. The USB ports support typical USB devices such as additional storage, GPS receivers, 802.11x WiFi equipment, packet TNCs, and so on. It has a 4 GB micro SD-card inside (which can be swapped for a larger one if you wish) 256 MB of DDR3 RAM, and it runs Linux with a bunch of 'extras' (like the AX.25 stack, APRX and the ircDDB Gateway). Then there's 12-VDC power, an antenna connector... and that's about it. Sweet and simple.

Oh, and a 25-watt radio. The transmitter also supports 5 and 10 W power levels, any frequency between 430 and 450 MHz, and a sub-10 mSec TX/RX switching time. The receiver has good sensitivity, switchable 25-kHz and 100-kHz filters, and an option for separated RX and TX antenna connections for high-RF environments. You can download a PDF spec sheet at <http://bit.ly/TfbgZW>.

Out of the box (which includes one UDRX-440 and a power cable) it runs the Linux AX.25 stack, and has ircDDB Gateway, Paclink UNIX, APRX, UDS Tracker, and other applications installed, so you won't be at a loss for ways to use it.

So, what can you do with all this?

EmComm

As you've read in these pages before, there are three basic ways to use Digital Data in EmComm:

1. 1200 Baud AX.25 packet (which can deliver text messages and transport them almost anywhere, but is glacially slow);
2. Repurposed WiFi equipment deployed as a mesh network (fast enough for Internet, but for only about as far as you can shout); and
3. HF data such as PACTOR III (which is also slow but has great range). All of these have their places.

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Fig. 2. UDRX-440 prototype, with the DV3000 card installed. This is a 25-watt data radio for the 430-450 MHz band that can run at 56 kb/s, and surely can be pushed somewhat higher. Also inside the package is a fairly powerful computer running Linux. On the left is the antenna (SMA in this prototype, Type N in production), and on the right are four USB connectors and the Ethernet port. (Photo courtesy of NW Digital Radio)

When there are no infrastructure problems, the Internet is *the* communications network. So, where infrastructure is either overloaded or gone, the real task of EmComm is to establish a reliable and fast connection to the nearest Internet access point. For the UDRX-440, establishing a fast link over tens of miles would be almost plug-n-play: Connect an antenna and power to one end, an Ethernet cable (or a WiFi Access Point) to the other, and your link is established.

For the first units sold, they'll only have 9k6 data capacity using AX.25, but both NW Digital Radio and others (it's open source) are expected to develop software updates for higher rates and additional protocols.

D-STAR

Getting on the D-STAR worldwide network can be done in a few ways: You can buy a D-STAR repeater and controller from ICOM (Full-duplex, not inexpensive but great quality), convert an existing analog repeater (which needs $400 software from ICOM for the gateway, or at least ircDDB Gateway software which is free, plus "some assembly"), or cobble up a D-STAR "hotspot" (as I described last May) for simplex operations. All are reasonable solutions, but other than the ICOM offering, all require various bits and pieces to be fashioned with skill into something functional.

The UDRX-440 has all that in a single package. With the built-in application processor, *ircDDB Gateway* and *DSTARrepeater* software (in simplex mode) run inside the radio package and feed data to the radio. Just add power, antenna and Internet and you have full connectivity to the D-STAR linking and reflector network. In this application, the UDRX-440 can run nearly 100% duty cycle at full power—quite unlike a typical mobile rig that might be pressed into service.

What Else?

What else can the UDRX-440 do? If you take a really close look, you'll find there isn't much it *can't* do. Keep in mind that I'm writing this before the first unit is available for sale—as I mentioned, NW Digital Radio expects to have units to ship a few weeks after you read this—so at the moment, the radio is somewhat hobbled by the limited available software. But just wait a few months, because as hams worldwide get their hands on these, you'll see a small explosion of new software updates, delivering capabilities that are limited only by your imagination (and, perhaps, you software writing abilities...). Data rates of 56 kb/s have been bandied about, hints of 100 kb/s+ rates being possible (limited, I suspect, by the wide 100-kHz receive filter), and I think you'll be hard-pressed to run out of CPU cycles for whatever you think you might want to do.

If you do happen to write something for the URDX-440, please share the knowledge with the rest of us. Although publishing my e-mail address brings me a boatload of spam, it also beings the occasional reader letter, which really brightens my day.

To help you along that path, visit the Yahoo support forum at <http://yahoo.it/1qqallf>. There you'll find the NW Digital Radio folks, along with developers from around the world. Some of the conversations go over my head (and I'm an Electrical Engineer with 35 years experience), but that's how we learn: Puzzle through it and ask questions. Learning new things is how I stay young; you should try it too.

PSK31 Under the Hood

Speaking about learning new things: I've written about PSK31 before, generally from the user's point of view, but an e-mail from Elwood Downey, WBØOEW, asked me how PSK31 decoding works. Good question! I don't know (yet) but allow me a month or two and I'll figure it out and let you know. I hope. If that falls through, I'm sure I'll find something to write about. Just in case, though, write to me and let me know what it is YOU would like to read, and I'll see what I can do. Until then . . .

73, Don N2IRZ

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